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ENVIRONMENTAL PROTECTION AGENCY
Managment Information and Data Systems Division
PM-218
Washington, D.C. 20460

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This document describes the procedure for preparing a feasibility study for procurement of a minicomputer.

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GUIDELINES FOR PREPARING

MINICOMPUTER FEASIBILITY STUDIES

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INTRODUCTION: APPLICATION FEASIBILITY STUDIES

This document describes the procedure for preparing a feasibility study for procurement of a minicomputer. This procedure should be employed within the larger framework of preparing an application-oriented feasibility study. The application study should address the broad questions of user needs and alternative ways of satisfying those needs. Within this broad analysis, one alternative to be evaluated is that of using minicomputers. It is within this context that the minicomputer guidelines document should be followed.

The broader application feasibility study should include four major tasks, as follows:

Analyze User Information Requirements

During this task, interviews are conducted with user representatives to determine the major functional and reporting requirements of the application. In addition, the benefits associated with each requirement are documented.

Evaluate Feasible Alternatives

During this task, an analysis is performed of the possible technical alternatives which can satisfy the identified information needs. These alternatives should include manual as well as ADP solutions if practicable. The alternatives are evaluated according to development cost, operating cost, ability to support functional needs, adaptability to future changes and enhancements, and relative technical and cost risks. It is during this task that a minicomputer solution should be posed and evaluated.

Recommend A System Alternative

As a result of the previous task, the alternative which provides the best functional support at the lowest cost and least risk is recommended. The development and operating costs for the recommended alternative then should be analyzed in greater detail.

Prepare Implementation Plan

During this task, a detailed set of actions is developed for implementing the selected alternative. Timing and cost estimates associated with each step are set forth also.

The results of each step in the application feasibility study should be documented in as much detail as possible into a final report for review by MIDSD and user organizations within EPA.

I. FUNCTIONAL REQUIREMENTS ANALYSIS

The primary purpose for using minicomputers at EPA is to reduce operating costs or to supply unique computing services. Although other factors may motivate users to want minicomputers, such as control or responsiveness, the primary focus of the feasibility study should be to demonstrate cost savings. Consequently, this guideline emphasizes those factors needed to demonstrate cost reduction.

The requirements analysis methodology includes five steps, as follows:

- Charting actual and projected data processing costs
- Decomposing costs to the application level
- Describing functional requirements and current processing of the high cost applications
- Identifying limitations of those applications
- Identifying system requirements of those applications

Each step is described briefly below. Checklists and general guidelines are provided for reference.

1. CHART ACTUAL AND PROJECTED DATA PROCESSING COSTS AND DETERMINE WHETHER FURTHER ANALYSIS IS NECESSARY.

Analyzing the actual and planned ADP costs provides an overview of the current situation, and criteria for deciding whether or not to go forward with the study. Actual ADP costs are derived from the TSSMS Consolidated Billing Report and from internal accounting information. Projected costs are derived from the Zero Based Budget. Operations which incur annual ADP costs of $150,000 or better, merit further consideration. Operations whose annual costs are between $70,000 and $150,000 require very important additional benefits to justify a minicomputer. Operations whose annual costs are under $70,000 will rarely be able to justify a minicomputer. If the current ADP costs are high, break out the annual expenditures into eleven cost categories, as follows:

- Batch
- TSO
- WYLBUR
- Printing
- Low Speed Connect Time
- High Speed Connect Time
- Online Storage
- Equipment Rental
- Equipment Maintenance
- Supplies
- Other

Most of these cost categories can be taken from TSSMS detail reports. Include percentage figures of total data processing costs. The resulting chart provides summary information of how ADP funds are spent. These data can be used in subsequent steps to help identify individual application costs and cost savings from proposed minicomputer usage. Exhibit 1-1, on the following page, is a sample chart showing ADP expenditures by cost category.

2. DECOMPOSE COSTS TO THE APPLICATION LEVEL.

Once the overall costs have been categorized, the analyst should decompose these costs by application system cost category. This application cost analysis will be used in subsequent steps to determine which applications or parts of application systems can be converted to a minicomputer. Specific application costs can be identified through ten steps, as follows:

- Identify applications
- Categorize applications as FORTRAN, COBOL, PL1 or other. FORTRAN applications, such as models, statistical reporting and laboratory calculations, suggest a different set of technical solutions than applications currently written in COBOL. PL1 applications will not run on most minicomputers.
- Enter cost data by category, (established above) for applications that are monitored as several accounts.
- Sum and enter costs data by category for applications that are monitored as several accounts.

EXHIBIT 1-1
SAMPLE OF ADP EXPENDITURES

	ADP EXPENDITURE ($000)	% OF OVERALL ADP EXPENDITURE ($000)
WYLBUR	156	17%
Batch	345	38%
Disk Storage	174	19%
Connect Charges	78	9%
Print Charges	45	5%
Other OSI Charges	8	1%
Data 100/74 Rental	17	2%
Data 100/78 Maintenance	6	1%
ADP Supplies	45	5%
Terminal Rental	26	3%
TOTAL	$900	100%

- For accounts that represent charges to more than one application, allocate costs that can be identified. Then distribute the remainder proportionately to those applications that might be included under the account. This method is a best approximation to compensate for accounting structures that are not application-oriented.

- Distribute unallocated high speed connect charges to applications in proportion to these print charges.

- Distribute unused online storage to applications in proportion to their used online storage.

- Add together all costs for each application.

- Subtotal costs by application category.

- Calculate application percentages of cost category and of total data processing charges.

The completed chart will identify high cost applications that require further study and consideration for conversion. Exhibit 1-2, on the following page, is a sample chart of expenditures by application. Application E in the exhibit is the highest cost operation and will be the dominant factor concerning whether or not a minicomputer is appropriate.

3. BRIEFLY DESCRIBE THE FUNCTIONAL REQUIREMENTS AND CURRENT PROCESSING OF THE MAJOR APPLICATIONS.

The functional requirements and current processing of the major applications should be described from six points of view, as follows:

- Legislative, regulatory, security and EPA internal requirements

- Information flows including inputs, outputs, and processing

- Controls required

- Interfaces with other systems

EXHIBIT 1-2
SAMPLE OF ADP EXPENDITURES BY APPLICATIONS

	A ($000)	B ($000)	C ($000)	D ($000)	E ($000)	TOTAL ($000)	% OF TOTAL OPP COMPUTER BILLINGS
WYLBUR	13	20	4	10	109	156	17%
Overnight Batch	37	4	2	31	113	187	21%
Other Batch	16	8	2	19	113	158	17%
Communication Charges	12	8	3	6	49	78	9%
Print Charges	11	2	1	2	29	45	5%
Disk	25	24	5	25	95	174	19%
Terminal Charges	-	-	-	-	49	49	6%
Supplies	-	-	-	-	45	45	5%
Other	2	-	-	-	6	8	1%
TOTAL	$116	$66	$17	$93	$608	$900	100%

. Workload

. Current equipment and software used

The completed paragraphs on each application present an overview of the functions provided and processing performed. These brief descriptions, in conjunction with the limitations identified in the next step, summarize the strengths and weaknesses of the current system.

4. IDENTIFY LIMITATIONS OF CURRENT SYSTEMS.

During this step, the analyst should examine functional and operational inadequacies in current systems that might be improved by conversion to a minicomputer. In analyzing the limitations of the current system, consider ten factors:

. Exposure to externally-imposed priorities and controls, such as central site equipment changes

. Inadequate turn-around time

. Poor data accuracy attributable to poor batch system edits

. Inadequate system design for managing data

  - Wrong level of detail
  - Data not available when needed
  - Information too out of date to support needs

. System inflexibility to changes in transaction and data storage volumes

. Processing bottlenecks and delays

. Unnecessary duplication of effort, especially in data preparation and editing

. Decreasing levels of service to users

. Poor staff morale

. Low equipment utilization

A review of these factors will provide a list of shortcomings of the current systems and operations. These shortcomings can be translated into a list of requirements for the proposed system.

II. SYSTEM REQUIREMENTS ANALYSIS

The system requirements are those hardware and operating system characteristics needed to support the functional requirements. In order to identify the system requirements, the functional requirements must be understood thoroughly, and a general application system design assumed. A design which parallels the current system, even if manual, is often adequate at this stage. There are many tradeoffs between application design and hardware. As the system requirements are identified and given priority, the configuration alternatives (and design alternatives) become clearer. There are five important categories of system requirements to be considered at this point, as follows:

- Performance Criteria
- Operations
- Data Base Characteristics
- Input, Output and Interfacing Requirements
- System Management Considerations

Each of these criteria will affect the definition of specific hardware and operating system support required.

1. PERFORMANCE CRITERIA MUST BE DEFINED IN ORDER TO IDENTIFY BASIC SYSTEM ALTERNATIVES.

There are nine important performance criteria to consider, as follows:

- Transaction rates (average and peak)
- Total throughout (quantity and rate)
  - Character transmission at the terminals (# characters input and output)
  - Character transmission to line printer
  - File accesses

. Response time requirements

. Maximum number of jobs running simultaneously

. Modes of jobs running simultaneously

  - Batch
  - Time shared
  - Real-time

. Types of jobs running simultaneously

  - Program development
  - Text editing or word processing
  - FORTRAN jobs such as models, statistic generation or laboratory calculations
  - COBOL/sort jobs
  - RJE
  - Real time data acquisition

. Class of peripherals that must be supported

. Availability

. Physical operating environment

This performance information provides a starting point for CPU and operating system selection.

2. <u>OPERATIONS REQUIREMENTS PROVIDE ADDITIONAL CRITERIA FOR SCREENING OPERATING SYSTEMS</u>.

Three operations requirements must be identified, as follows:

. Program sizes
. Languages
. Floating point capability

Application system requirements in these areas will determine whether current code can be transferred to a minicomputer or whether substantial redesign or reprogramming will be necessary for conversion.

3. DATA BASE CHARACTERISTICS ARE NEEDED TO IDENTIFY REQUIREMENTS FOR ONLINE AND OFFLINE STORAGE AND DATA BASE MANAGEMENT SOFTWARE.

There are four primary areas that need consideration, as follows:

. Size

- Total number of files
- Total number of records
- Total number of characters
- Record sizes

. Structure and Complexity

- Fixed or variable length records
- Fixed or variable length fields
- Multiple subfields
- Absent fields
- Hierarchical groups
- Interrelationships of fields and records

. Access

- Method (random, sequential, indirect, indexed sequential)
- Length of access keys
- Number of access keys per record
- Interrelationships between data files

. Activity

- Frequency of reference
- File activity ratio (number of records used/number of records scanned)

- Speed

- Rate of change

- Rate of growth

Data base size parameters will determine overall storage capacity requirements, whereas activity factors distinguish online storage from offline storage. The structure of the data base and access methods required provide the criteria for selecting file management or data base management systems or procedures for use in converted systems. For example, the absence of indexed sequential access methods on DEC computers means that special program products (RMS) must be obtained to support index sequential access.

4. INPUT, OUTPUT AND COMMUNICATIONS REQUIREMENTS MUST BE IDENTIFIED IN ORDER TO MAKE TERMINAL, PRINTER AND INTERFACE SELECTIONS.

Characteristics to be identified for these three requirement categories are as follows:

. Terminal Input and Output (see Guide to EPA Standard Data Processing Communications Terminals)

. Printed Output

- Character set (uppercase vs upper/lower case)
- Volume
- Backup
- Turn-around time
- Frequency
- Noise tolerance
- Distribution

. Communications

- Terminal lines
- RJE Univac 1004 or 9200 emulator
- RJE IBM 370 (HASP) emulator

Input, output and communications requirements are all related closely and should be considered together.

5. SYSTEM MANAGEMENT CONSIDERATIONS INCLUDE SYSTEM GROWTH, RELIABILITY, SECURITY AND CONTROL, AVAILABILITY, MAINTAINABILITY AND COMPATIBILITY REQUIREMENTS.

Although less tangible than performance criteria, data base requirements or input/output requirements, these five management considerations strongly impact the hardware selection process.

System growth and life expectancy must be determined so that modular expansion can be planned, and so that cost/benefit analysis reflects paybacks accurately. Four considerations relating to system growth and life expectancy must be considered, as follows:

- Life cycle of applications
- Rate of enhancement anticipated
- New applications expected
- Growth of data base and respective effect on current applications

Analysis of these considerations will indicate the total processing capability and storage capacity required over the next few years and will suggest the expansion capabilities needed in the initial configuration.

Reliability requirements (mean time between failure and mean time to repair) are needed for determining how much duplication must be provided for backup and recovery. Reliability must be considered in five areas, as follows:

- Timeliness of printed reports
- Timeliness of data entry
- Protection of data base
- Political sensitivity of users to down-time
- Special laboratory requirements

Evaluation of these five reliability considerations will suggest whether one printer or one disk is adequate for the system.

Security and control requirements may imply that computing hardware should have restricted access, or an operating system that provides structured, limited or monitored access. Security and control should be considered from seven points of view, as follows:

- Access to data base
- Update of data base
- Execution of certain programs
- Quality assurance
- Output control including distribution logs, audit trails, and control totals
- Input controls such as data entry validation
- Processing controls such as checkpoints and error logs

Availability requirements suggest implementation schemes and quantity of various hardware components. For example, if a particular application with a large data base is run infrequently, the data base may be stored offline on a disk pack rather than online.

Compatibility requirements may suggest centralized rather than decentralized equipment or may demand specific hardware components that are the same at another installation. There are three primary compatibility issues to examine at EPA, as follows:

- Shared data bases
- Shared or similar programs
- Equipment backup for other systems

Analysis of compatibility issues may indicate that conversion to a minicomputer is not feasible or it may limit the hardware alternatives to virtually identical systems already installed.

The completion of system requirements identification provides a translation of functional requirements into technical parameters. These parameters provide a concrete set of criteria against which alternative hardware can be measured.

These requirements should be documented in a working paper outline and may be included as an appendix to the feasibility study. Analysis must then be made to determine priorities for these requirements. The most important needs become the primary evaluation criteria for hardware selection.

There are many tradeoffs between the requirements, hardware availability and cost. The outline and evaluation criteria provide a checklist and guideline to help maintain objectivity during the alternative selection process.

III. FEASIBLE ALTERNATIVES DESCRIPTION AND HARDWARE CONFIGURATION

Alternative solutions are identified to insure that the recommended solution has been selected after due consideration of potentially less risky or less expensive alternatives. Business alternatives range from the current method, to conversion of a subset of the applications, to conversion of all applications and development of new applications on a minicomputer. One or more technical solutions must be provided for each business alternative. This section of the feasibility study should include three to five business alternatives and each should be described in terms of the functional capabilities provided and in terms of the hardware/software configuration assumed.

Functional capability descriptions consist of one to two paragraphs describing the applications to be included with each configuration proposed. Major features, limitations and growth potential should be highlighted for each alternative.

Hardware/Software configuration descriptions consist of specific hardware, telecommunication and software components of configuration solutions that technically satisfy the business requirements of each alternative identified. Configuration definitions include ten major components, as follows:

- CPU
- Memory
- Disk
- Magnetic tape
- Printers
- Miscellaneous peripherals
- Cabinets and special hardware
- Console and terminals
- Communications
- Software

These ten components constitute the major cost items. Most components can be identified by using the guidelines provided on the following pages. However, the vendor sales representative should be consulted to check the proposed configuration and confirm the local hardware cost.

The standard EPA minicomputer configuration is a DIGITAL Equipment Corporation PDP 11/70 CPU with the IAS Operating System. The details of the standard configuration are shown in Appendix A.

For special situations there are a variety of alternatives to the standard. A list of alternative DIGITAL components and associated prices is provided in the contract between DIGITAL and EPA. This list must be used to acquire costs for the individual components. It is best to use the price list and this guideline side by side while configuring the system. Be sure to have also all price list amendments. At this time other vendors would not be practical unless they provide required functionality which DIGITAL cannot supply. Procurement of equipment from other vendors is such a long process that any cost benefits recognized at the time of study could be dissipated rapidly.

The following pages provide guidelines for applying the EPA standard or slightly modifying the standard to meet different needs. Because the PDP 11/70 is the standard, most guidelines relate to 11/70 options. For more detailed analysis, information about new options and final configuring, the DIGITAL sales representative must be consulted.

The component descriptions follow. More detailed descriptions of various options are provided in the PDP 11 Peripherals Handbook, the PDP 11 Software Handbook and PDP 11 processor handbooks, all produced by DIGITAL.

1. THERE ARE THREE ALTERNATIVE CPU'S FROM WHICH TO CHOOSE.

   The PDP 11/70 is the standard CPU for EPA. However, for special situations, two other CPUs may be considered. The three CPUs discussed are:

   - PDP 11/70
   - PDP 11/45
   - PDP 11/34

   The 11/70 with the IAS Operating System is recommended for concurrent batch, real-time and timesharing applications in the larger configurations and pairs of these in smaller configurations. The 11/70 has special high speed data paths which provide faster processing than the other two choices. Up to 1024K words of memory may be added to the 11/70 making this computer considerably more expandable than the 11/45 or the 11/34, which is limited to 124K words of memory.

   The 11/45 with the RSX11-M operating system is appropriate for limited RJE operations in conjunction with multitasking laboratory problems that may be solved with FORTRAN. It is not suitable for

multitasking COBOL jobs with RJE and batch processing. The 11/45 is limited in memory capacity to 124K words and therefore is not as expandable as the 11/70.

The 11/34 is the smallest PDP 11 that may be considered for EPA purposes. Combined with the RSX11-M operating system it is adequate for low activity laboratory work that supports up to four online users.

Generally the 11/70 will be the choice. That configuration handles RJE, text editing, reporting and tracking applications, modelling and laboratory needs. The 11/45 and 11/34 satisfy fewer needs and are not as expandable as the 11/70.

2. MEMORY SHOULD BE ACQUIRED IN 128K WORD INCREMENTS.

The 11/70 uses only MJ11 memory. The memory recommended for EPA at this time is:

- MJ11-BA, 64K words
- MJ11-BE, 64K words, and frame

There are two MJ11 memory series, A and B. The A series is minimally faster and more expensive than the B series. The B series comes in 64K word increments and 256K word increments. EPA can improve performance by interleaving memory blocks. Interleaving requires that memory be incremented two blocks at a time. It also requires two frames. Interleaving of 64K word blocks is recommended for all systems. The capacity of two 256K word blocks are not required by EPA, at this time.

Configuring the total memory is a matter of identifying four individual requirements, as follows:

- System software requirements
- Interactive requirements
- Real-time requirements
- Batch requirements

Once the memory is determined for these processes, the total system can be configured by summing the individual requirements and rounding up to the next 128K word increment. The 11/70 interleaved memory requires a minimum of 128K and must be incremented by 128K.

The system software, IAS, requires 32K words to 46K words for system-related components, depending on which device handlers are loaded. For the purpose of the feasibility study, 46K should be assumed.

Interactive requirements are based on the number of online terminals. To take into consideration both periods of inactivity and normal peaks, identify the number of interactive (non-RJE) terminals required and multiply that by 75%. Then multiply the product by 16K words. The final result is the total memory required for timesharing. (This guideline assumes a 75% interactive and 25% computational mix.)

For each RJE/IBM interface, allocate 14K words. For each RJE/Univac interface, add 11K words.

Allocate 16K for each batch stream which would run concurrently with timesharing or real-time applications. Note that if more than two simultaneous batch streams are required to complete batch processing in the allotted time, then the 11/70 is probably not a powerful enough alternative. The number of simultaneous streams required is determined by estimating the number of record reads and writes required, dividing that by 36,000, dividing again by the hours available to run the batch program, and rounding to the next whole number.

The last step for determining memory required is to add the individual requirements identified and then to round that sum up to the nearest 128K increment. The first 128K increment must be two MJ11-BAs; the next three required should be two MJ11-BEs each.

On configurations of 128K words or greater, IAS gives excellent performance characteristics.

3. MOST EPA SYSTEMS SHOULD USE TWO RPO4 DISK DRIVES.

IAS requires a disk system. There are three PDP 11/70 disk system choices applicable to EPA, as follows:

- RPO4 (RWPO4-AA, RPO4-AA, RPO4-P)
- RPO5 (RWPO5-AA, RPO5-AA, RPO5-P)
- RPO6 (RWPO6-AA, RPO6-AA, RPO6-P)

The minimum disk system required by IAS is a controller, a drive and a disk pack. One disk pack is standard equipment with each disk

drive. There are five primary factors that must be considered to configure mass storage systems, as follows:

- Type of disk storage
- Storage capacity
- Backup
- Cost
- Throughput

The first consideration for configuring a disk system is to select the type of storage. There are three basic types of disks for the 11/70: single access pack drives, dual access pack drives, and fixed head disk drives. However, only single access pack drives are applicable for EPA at this time. These drives are coded as RWPOn-AA (controller and pack included), and RPOn-AA (pack included) in the price list. Additional packs are coded as RPOn-P. The minimum requirement imposed by IAS is one RWPOn-AA unit.

Dual access disks require two CPUs and are used generally in systems that require very high reliability. EPA has no current requirement for dual access. These drives are coded as RWPOn-BA and RPOn-BA in the price list and should be ignored.

Currently, EPA does not process any applications that require a fixed head disk for storage. Future applications that would merit fixed head disks are those which require high data throughput rates such as real-time data acquisition systems or control systems. Also, the disk may be used to hold file directories of specific files that require fast access. Another usage for fixed head disks is an alternate to movable head disks for program swapping areas in order to improve application performance. However, this is very expensive and provides comparatively little benefit, and is therefore not recommended. The fixed head disks are coded as RWSOn-BA on the price list and generally should not be used for EPA purposes.

The second disk system consideration is storage capacity. There are two storage capacities available and three RPOn disks to choose from, as follows:

- RPO4, 44 million word disk
- RPO5, 44 million word disk, upgradable to the RPO6
- RPO6, 88 million word disk

Currently, the RPO4 is the EPA standard. At the time of this writing, further investigation is underway to compare the reliability and functionality of the RPO4 to the RPO5.

The amount of disk storage required is determined from data base size and anticipated growth plus programs, swapping area for running programs, temporary work space and system software. Because a single file may not span more than one disk, with the exception that the directories may be separate from the data, the disk capacity chosen must satisfy the largest data file. Growth factors should be considered. If the system requires more than three or four disks for online storage, the problem is probably better satisfied by another technical solution.

It is recommended that drive varieties not be mixed for three reasons, as follows:

- Enhanced backup and recovery due to pack transfer between drives
- Improved serviceability and maintainability
- Reduced inventory of packs

Backup is the third major consideration for selecting a disk system. Two drives are recommended as a minimum configuration. Also, two drives provide backup in case of failure. By isolating applications and their respective data base to particular packs, a disk failure can merely mean degraded operation rather than complete shutdown. In order to take advantage of this capability, the RPO4 drives must have an add-on module, the RPO4-H for $550. This add-on enables the drive unit number to be changed without field service. The RPO5 and RPO6 drives have this feature built in.

The fourth disk system consideration is cost. If the disk configuration appears to require more than two drives, the applications should be analyzed individually. If several applications can be isolated to specific packs and be limited to running during fixed periods, then online storage is not required. The cost is merely additional packs and not additional drives.

Throughput is the fifth disk system consideration. Reporting and tracking, RJE and text editing applications do not require high disk throughput. The simplified discussion on throughput that follows provides a guideline for possible future requirements.

Often, disk throughput can be improved through disk hardware by four different methods, as follows:

- Faster disks
- Use of fixed head disks
- Multiple disks of a smaller storage capacity
- Additional controllers for the additional disks

There are many factors involved in calculating disk throughput. Throughput is dependent on the type of applications and data bases as well as the system software and hardware. General guidelines for improving throughput do not always apply. It is recommended that a specialist evaluate the requirements and resources and suggest configuration alternatives if disk throughput becomes a major consideration.

In summary, two drives are recommended for all EPA systems, for enhanced backup and recovery capabilities. The RP family of disks are the best choices for the 11/70. The RP04 is currently the standard.

4. MOST EPA SYSTEMS SHOULD HAVE AT LEAST ONE TU16 TAPE DRIVE.

Two tape drives with industry compatible data formats are available, as follows:

- TU16 (TJU16-EA, TU16-EE)
- TM11 (TMB11-EA, TU10W-EE)

One of the two is required by IAS. The TJU16-EA is a program selectable 800 bpi or 1600 bpi, 9-track magnetic tape transport and control unit. It is expandable to a total of eight TU16 transports. Reading and writing are performed at 45 inches per second. The TMB11-EA is a 200 bpi, 556 bpi or 800 bpi, 7-track and 800 bpi, 9-track magnetic tape transport and control unit. It is expandable to a total of eight TU10W transports. Reading and writing are performed at 45 inches per second. If there are any external magnetic tape interfaces which require 200 bpi, 556 or 800 bpi, 7-track tapes, then the TM11 unit must be selected. Otherwise, the TU16 is recommended. The number of transports required is a factor of the quantity of tape to be read and written during the day.

Applications that were previously tape-based should be considered for conversion to disk because DIGITAL's magnetic tape units are slow.

Generally, the tape system will be adequate and more cost effective for the day-by-day precautionary backup of the data base. For 1600 bpi tape on the TM11 system, one fully loaded 44 megabyte disk can be copied in 42 minutes. (This calculation is based on a blocking factor of 1024 words and includes load, rewind and unload time.) Precautionary backup to disk packs only becomes feasible when the online data base is very large and time becomes a consideration.

DIGITAL supplies each magnetic tape drive with two reels.

5. LINE PRINTER SELECTION IS DEPENDENT PRIMARILY UPON PRINT VOLUMES AND BACKUP.

There are five choices for printers, as follows:

	LA11-PA:	128 character set,	180 chars/sec
.	LP11-US:	64 character set,	300 lines/minute
.	LP11-WA:	96 character set,	230 lines/minute
.	LP11-RA:	64 character set,	1200 lines/minute
.	LP11-SA:	96 character set,	900 lines/minute

All are 132 column printers. The RJE/IBM interface requires an LP11 line printer. The difference between the printers are character set and speed. If upper and lower case printout is required, then the LP11-SA, LP11-WA or LA11-PA (very slow) is necessary. Speed can sometimes be traded for number of printers.

Five considerations must be analyzed to determine the speed required and the number of printers required, as follows:

- Volume of printed material and timeliness requirements
- Backup
- Types of applications
- Availability
- Work flow

Analysis of these considerations will provide clear criteria for selecting a printer.

The speed chosen is based partially on the operational line printer requirements derived from the current number of lines printed, plus anticipated growth. Although some printing may be replaced with online inquiry, adjustments for the online capability should not be made until accurate data reflecting such changes are available. Program listings, diagnostic printouts and file dumps for development maintenance and trouble shooting also should be factored into the volume estimate.

Printer backup requirements are especially important. The line printer is the least reliable component of the entire configuration. If particular reports have critical deadlines, then two printers may be required to assure completion of those reports.

For development, a 1200 line per minute printer in addition to a 300 line per minute printer for RJE output may be appropriate. This configuration may also satisfy backup requirements for a few reports. Applications that produce a high volume of reports or environments with heavy software development with many compiles may require two fast line printers. Space availability may suggest one printer, however. Nonetheless, location requirements for efficient work flow may require multiple printers. All these factors may be weighted in order to select the printers that best satisfy the system needs.

6. SOME SYSTEMS MAY REQUIRE OTHER PERIPHERALS FOR SPECIAL NEEDS.

Two other peripherals may be required, as follows:

- Card readers
- Paper tape readers/punch

The 300 card per minute card reader, CR11, is a minimum hardware requirement for the RJE/HASP interface.

Although this card reader should satisfy most RJE requirements, two other faster card readers are available, as follows:

- CD11-A
- CD11-EA

The CD11-A version is a tabletop unit with an input hopper capacity of 1000 cards and operates at 1000 cards per minute. The CD11-EA version is a free standing floor model with a large 2250 card hopper that has a speed of 1200 cards per minute.

DIGITAL provides only one paper tape reader/punch. That unit is capable of reading eight-holed unoiled perforated paper tape at 300 characters per second, and punching tape at 50 characters per second.

Other special function peripherals are also provided by DIGITAL. If future applications require such peripherals, consult your DIGITAL sales representative for pertinent information.

7. CABINETS AND SPECIAL HARDWARE WILL COST SEVERAL THOUSAND DOLLARS.

Cabinets, mounting boxes, system units, unibus extension units, and other special hardware add up to several thousand dollars and should not be omitted from the solution costs. They are configured after the rest of the hardware is selected. These items are a factor of other components and require detailed knowledge of the configuration process. It is recommended that this task be performed by the DIGITAL representative during the review of the proposal selections.

8. THE NUMBER OF TERMINALS SELECTED IS A FACTOR OF PRODUCTION USAGE AND DEVELOPMENT USAGE.

The first step in selection is to determine how many terminals are required. Identify the number of production terminals required based on current and planned usage. Then add one development terminal, 9600 baud, for every two implementors performing concentrated development or conversion.

The next step is to select the type of terminals. The system console recommended is the DECwriter II, LA36. The terminals selected must be either DIGITAL or EPA approved terminals as described in the Guide to EPA Standard Communications Terminals. That document provides complete details on each of the approved alternatives and provides complete instructions regarding the selection of terminals.

9. COMMUNICATIONS HARDWARE MUST BE SELECTED FOR TERMINALS AND EXTERNAL RJE INTERFACES.

Online terminals require asynchronous multiplexers. The RJE operations require single line synchronous interfaces. Other supporting communications hardware such as modems, cables or line adapters may be required also.

An asynchronous multiplexer is required to connect multiple terminals (local and/or remote) to the computer. There are two basic choices available, as follows:

- The DZ11 series
- The DH11 series

The DZ11 is much lower in cost than the DH11. However, the DZ11 does not handle NPR (non-processor request or direct memory access) transfers and therefore limits the system's ability to support large numbers of terminals. A general guideline is to use DZ11's when the total continuous throughput for the system required is less than 1000 characters per second. When higher throughput is required, DH11's should be used. Consider the baud rates, number of users and type of processing to estimate total characters per second required.

After the choice between a DZ11 and DH11 is made, the particular model required must be selected. For the DZ11 there are four models, as follows:

- DZ11-A: 8 lines, EIA interface
- DZ11-C: 8 lines, 20mA interface
- DZ11-E: 16 lines, EIA interface
- DZ11-F: 16 lines, 20mA interface

The choice between eight or sixteen lines is based on the number of terminals required. The eight line models are field upgradable to sixteen lines.

The choice between EIA/CCITT and 20mA current loop interfaces generally will result in the selection of EIA/CCITT. An EIA/CCITT interface is more reliable and more flexible than a 20mA interface, but requires a modem if the line length is greater than 1000 feet. The 20mA interface is being phased out gradually by the industry, but does not require a modem for remote locations. The EIA/CCITT interface is recommended for consistency, backup, maintainability and serviceability.

If the asynchronous multiplexer category choice is a DH11 rather than a DZ11, then a selection must be made from three DH11 models, as follows:

- DH11-AA
- DH11-AD
- DH11-AE

The DH11-AA model is a sixteen line multiplexer that can support both EIA/CCITT and 20mA current loop lines. However, if a mix is needed, DM11 line adapters must be added to the multiplexer. The DH11-AD and DH11-AE models support sixteen EIA/CCITT lines. The AD model is required for switched network connections (general telephone network), while the AE model is used for private or leased line service. Unless the volume of the data transmission from a remote location is very high, or there is a severe reliability problem using the switched network service, the higher cost of a private line cannot be justified.

For EPA at this time, the DH11-AD will be the common choice. The DH11 supports more terminals than the DZ11. All EIA type lines are recommended. Switched network service should be sufficient for remote locations. Cables and modems are not included with the DH11-AD and must be configured.

A synchronous interface is required for each RJE operation. DIGITAL provides three types, as follows:

- DU11-DA
- DQ11-DA
- DV11

The DU11 is the only interface supported by RJE/UNIVAC Emulator software. Therefore, one DU11 must be configured for each Univac interface. At the time of this writing the DV11, an 8 or 16 line synchronous multiplexer is reportedly the most reliable interface, but is not yet supported by IAS. That leaves the DU11 and DQ11 as valid choices for RJE/IBM operations. The DU11 satisfies low speed (up to 9600 baud) data transmission, but the DQ11 is required for high speed (up to 1 megabaud) data transmission. Exhibit 3-1, on the following page, should aid in selection of communication interfaces to satisfy concurrent emulators. Both the DU11 and DQ11 require hardware to perform error checking on the data being transmitted over the lines. This capability is provided by the KG11-A unit. The number of units required for different configurations is shown in Exhibit 3-1.

EXHIBIT 3-1
SELECTION MATRIX FOR EMULATOR HARDWARE

WITH THIS HARDWARE . . . . .

		1-DQ11 1-DU11 2-KG11	2-DU11 2-KG11	2-DU11 1-KG11	1-DQ11 1-DU11 1-KG11
YOU WILL BE ABLE TO RUN THESE COMBINATIONS CONCURRENTLY	HI SPEED HASP & LO SPEED HASP	YES	NO	NO	NO
	HI SPEED HASP & UN1004	YES	NO	NO	YES
	LO SPEED HASP & UN1004	YES	YES	YES	YES
	LO SPEED HASP & LO SPEED HASP	YES	YES	NO	NO

10. FOUR SOFTWARE CATEGORIES MUST BE CONSIDERED FOR PROCUREMENT ALONG WITH THE HARDWARE.

There are four areas of software that should be considered currently, as follows:

- Operating system
- Programming languages
- Telecommunications control
- Utilities/support

In the future, more software will be available and the choices will be expanded. Currently the options to be considered for configuring a system are limited.

The operating system for an 11/70 configuration must be IAS. For the 11/45 or 11/34 CPU it must be RSX11-M.

IAS supports both COBOL and FORTRAN programming languages. RSX11-M supports FORTRAN, but not COBOL. FORTRAN may be purchased in two versions, FORTRAN IV and FORTRAN IV-PLUS. FORTRAN IV compiles quickly but executes more slowly than FORTRAN IV-PLUS. FORTRAN IV-PLUS executes much faster than FORTRAN IV, but compiles more slowly. Both meet ANSI FORTRAN IV specifications, but differ in their extended language capabilities. For conversion from IBM or Univac programs, the two versions should be evaluated for the best match in instruction set. The PDP 11 Software Handbook provides a synopsis and comparison chart for each version. If FORTRAN IV-PLUS is chosen, a floating point processor option to the CPU is required. The floating point processor that should be selected is the FP11-C for the 11/70 and 11/45 or the FP11-AU for the 11/34.

Telecommunications control for EPA primarily means software to handle the emulators. There are two packages available, as follows:

- IBM RJE/IAS software with full support
- UNIVAC RJE/IAS software with full support

Utilities and support are provided by DIGITAL as part of the operating system.

An operating system and programming language must be purchased for the proposed system and therefore included in the configuration. Telecommunication software selection depends upon the applications proposed for implementation.

IV. COST BENEFIT ANALYSIS

The third major activity of the feasibility study is an analysis of each alternative according to its relative costs and benefits. This activity provides a means to measure the "value" of each alternative. The cost analysis should identify the new costs to be created by each alternative and should examine the resulting effect on existing costs. In addition, the analysis should address cash flow considerations.

Prepare a cost/benefit summary for each alternative solution proposed. The first step is to analyze the principal costs. There are eight cost categories that should be itemized in the summary, as follows:

- Hardware and software procurement or lease
- Software conversion and development
- Maintenance
- Supplies
- Personnel including operations staff, development and maintenance staff, supervisors and clerical support (Exhibit 4-1 following this page presents sample staffing levels)
- Site preparation
- Training
- Data conversion, installation, and parallel operations

Once the costs have been identified, five additional cost related steps must be performed, as follows:

- Analyze ADP cost savings
- Represent costs and benefits over a five year period
- Omit inflation adjustments because they usually affect all alternatives equally

EXHIBIT 4-1
STAFFING LEVELS FOR A TYPICAL MINICOMPUTER

PERSONNEL	TECHNICAL EXPERTISE	NUMBER*
Minicomputer Operator	RJE terminal operator with DEC training	1 per shift
Operations Supervisor	RJE operations supervisor or equivalent	1
System Programmer	Training in IAS fundamentals and EPA software packages	1
Data Entry Clerks		Depends on applications
Other Clerical Suppert		1 administrative assistant (optional)
Application Programmers		Varies with the applications

* Minicomputer personnel may be either government or contractor personnel.

- Factor in the system growth and business considerations that may affect year-to-year operating costs

- Associate costs and benefits with the years in which they actually will take place

The completed cost charts for each alternative provide an easy means of comparing the alternatives for the most cost effective solution.

In addition to the cost summaries, benefit and risk summaries should be provided for each alternative. Briefly describe the advantages and disadvantages of each alternative in terms of functionality, meeting of major business requirements and risk.

At the completion of the cost/benefit analysis phase, each alternative is represented by cost and evaluated against the same criteria. The composite data provide the material necessary to make a recommendation.

V. RECOMMENDATIONS

As a result of the cost/benefit analysis, a recommendation should be presented to management.

Normally the least-cost alternative provides the best solution to problems with mandatory requirements and tangible objectives. Solutions for problems with intangible objectives require more subjective justification and are harder to sell to senior management. In either case, determination of the best choice is often a compromise between economic benefits and technical sophistication. Smaller, simpler machine solutions involve smaller investment of resources but yield fewer technical benefits to support changing functional needs. Greater investment of resources in larger machines yield greater technical returns but at greater economic risk. Such choices are resolved based on a management assessment of the economic costs and associated technical benefits. Occasionally, two choices that appear equally suitable are recommended to management for selection.

The results of the feasibility study should be documented in the format requested in the EPA Automatic Data Processing Manual, Chapter 6, Appendix A -- "Guidelines for the Preparation of a Feasibility Study".

APPENDIX A

STANDARD EPA 11/70 APPLICATION

The standard PDP 11/70 - IAS V.1.1 System will be configured to support at least the following concurrent operations:

(1) Real-time partition — one of the following:

1. HASP/IAS, running at 4800 BPS, or
2. UNIVAC 1004/IAS, running at 4800 BPS

(2) Twelve simultaneous users, each with a maximum virtual partition, doing interactive editing (EDI) on FORTRAN IV PLUS, BASIC, COBOL, and data files, with submission of compiles and executes to Batch. The COBOL task level is expected to be on the order of 5% of all system tasks and not more than one COBOL task being executed at any one time.

STANDARD EPA CONFIGURATION 11/70
FOR ORDERS PLACED AFTER 9/30/76

ITEM	MODEL NO.	DESCRIPTION	SHIPPING & DRAYAGE	DISCOUNTED PURCHASE PRICE
1	11/70-NA	Processor With 64K Words	559	55,885.00
2	FP11-C	Floating Point Processor	53	5,310.00
3	MJ11-AA	32K Word Parity Core Memory With Expansion Capability to 256K	127	12,735.00
4	MJ11-AE	32K Word Parity Expander Core Memory	67	6,705.00
5	CR11	300 CPM Card Reader	41	4,140.00
6	RWP04-AA	44M Word Disk Drive + Controller	350	35,000.00
7	TWU16-EA	1600/800 BPI 9 Track Tape Drive	146	14,648.00
8	LP11-RA	1200 LPM Line Printer	350	34,965.00
9	DZ11-E	16-Line Asynchronous Multiplexer Programmable	31	3,060.00
9A	BC05D-25	25' Modem Cable For Remote VT52-AE or VT55-EE/FE (one per modem)	1	108.00
		FOR LOW OR HIGH SPEED (UP TO 9600 BAUD) HASP EMULATOR		
10A	DQ11-DA	Synchronous Interface (NPR)	39	3,921.00
10B	KG11-A	CRC/LRC Arithmetic Element	9	941.00
10C	HASP/IAS	Software	N/C	5,000.00
		FOR LOW SPEED ONLY (UP TO 4800 BAUD) HASP EMULATOR		
11A	DU11-DA	Synchronous Interface	9	941.00
11B	KG11-A		9	941.00
11C	HASP/IAS	Software	N/C	5,000.00
		FOR UNIVAC 1004 EMULATOR		
12A	DU11-DA	Synchronous Interface	9	941.00
12B	UN1004/IAS	Software	N/C	5,000.00

ITEM	MODEL NO.	DESCRIPTION		SHIPPING & DRAYAGE	DISCOUNTED PURCHASE PRICE
13A	VT52-AE	DECscope Video Terminal and/or	Any combination of remote and/or	19	1,886.00
	VT55-FE	Graphics Terminal w/copy and/or	local terminals up to 16 MAX. on	36	3,596.00
	VT55-EE	Graphics Terminal	one DZ11-E.	22	2,246.00
13B	BC05D-25	Modem Cable for Remote VT52-AE or VT55-FE/EE (one per modem)		1	108.00
13C	BC03M-XX	Interface for local VT52-AE or VT55-FE/EE (one per terminal) in the following cable lengths:			
	BC03M-25	25'		1	50.00
	BC03M-A0	100'		1	99.00
	BC03M-B5	250'		1	149.00
	BC03M-E0	500'		2	248.00
	BC03M-L0	1,000'		5	495.00
14	LA36-CE	(20Ma) DECwriter Console		21	2,115.00
15	H960-DH	Cabinet		30	2,970.00
16	DD11-C	System Unit		3	270.00
17	QP210-AD	IAS V.1.1 Software (Includes 5 Training Credits)		N/C	7,020.00
18	QP200-AD	FORTRAN IV + Software		N/C	2,700.00
19	QP010-AD	COBOL Compiler		N/C	6,300.00

ADD - ONS

ITEM	QUANTITY	MODEL NO.	DESCRIPTION	ADD-ON INSTALL.	SHIPPING & DRAYAGE	DISCOUNTED PURCHASE PRICE
1	1	RPO4-AA	2nd 44M Word Drive	585	259	25,900.00
2	2	MJ11-AE	32K Word Memory @ 6,705 ea. for a total of 64K Words Installation $145 Shipping $67	290	134	13,410.00

START-UP SUPPLIES

ITEM	DESCRIPTION	QUANTITY	UNIT PRICE	AMOUNT
1	RPO4-P Disk Packs	3	600.00	1,800.00
2	TUMAG-24 Large Supply Kit Incl. 20-2400' Mag Tapes	1	360.00	360.00
3	36-09141 Printer Paper for DECwriter and Line Printer	5	32.00	160.00
4	36-10558-01 DECwriter Ribbon — 12 per box	1	50.00	50.00
5	18-10156 Line Printer Ribbon	2	35.00	70.00